MOLECULAR BIOLOGY

STUDY OF THE BIOMECHANICAL PROPERTIES OF ELASTOMERIC PROTEINS USING THE ATOMIC FORCE MICROSCOPE.

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Elastic proteins are found in a wide variety of biological systems. They have evolved uniquely determining their mechanical properties. The best known proteins in vertebrate muscles and connective tissues, are collagen, titin, elastin and fibrillin in spider silks. These elastomeric proteins differ considerably in amino acid sequence, but they are polymers whose subunits contain elastomeric domains, composed of repeated motifs, and non-elastic domains that mediate cross-linking between the subunits.

To examine the mechanical properties of various elastomeric biological samples, at the microscopic level, we measured their elastic modulus using an atomic force microscope (AFM). This instrument was home-built and has several important improvements over commercial instruments, the most important being its low drift and higher positioning and force resolution. The elastic modulus was determined by measuring the elastic displacement of the sample by the AFM tip for a given applied force. The main advantage of using the AFM in these studies is that it is possible to study the biomechanical properties of different samples at the macroscopic level and also at the single protein level.

Using this tool we evaluated the mechanical properties of tropoelastin. Tropoelastin is a precursor of elastin and is found in many tissues which need to flex such as arteries, muscles and lungs. We have found that tropoelastin is able to undergo significant deformation, without rupture, before returning to their original state when the stress is removed. We found that the elastic modulus is 0.1 MPascals a value that is similar to rubber or 2% agarose, but 1000-fold softer than silk or mica.

We are planning to use this novel approach to characterize the underlying changes in the mechanical properties of tissues with aging and pathology.